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71 Applicant: Sacks, Michael  
43 Woodhall Avenue Whitefield  
Manchester(GB)

72 Inventor: Sacks, Michael  
43 Woodhall Avenue Whitefield  
Manchester(GB)

74 Representative: Quest, Barry (GB) et al,  
M'Caw & Co. Saxone House 52-56 Market Street  
GB-Manchester M1 1PP(GB)

54 **Protective shields.**

57 A protective shield which can be used as a personal bullet-proof shield has a front supported layer and a rear penetration resisting and impact-absorbing backing structure.

The front supported layer comprises a sheet (B) of a rigid, brittle material, such as a sheet of ceramic plates.

The backing structure may comprise layers of a woven fabric made from aramid fibres (D).

The front supported layer and the rear backing structure can be provided in separate pouches of a bullet-proof vest.

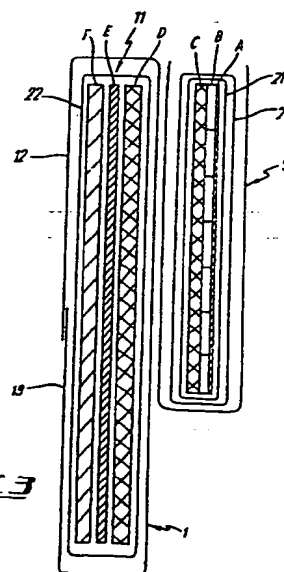


FIG. 3

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PROTECTIVE SHIELDS

This invention relates to a protective shield, particularly although not exclusively a bullet-proof shield.

5.

In my earlier Patent Application No. 1,556,245 there is disclosed a protective shield to be used in front of a person's body to protect such person against injury by a bullet or other missile or moving object, said shield

10. having one or more layers of a closely woven fabric which is made from aramid fibres of high tensile strength and high stretch resistance such as to be capable of resisting penetration by a bullet, and one or more sheets formed from an impact-absorbing plastics material
15. arranged on that side of said fabric which in use faces the person's body.

With this arrangement, effective protection can be afforded against low velocity missiles but it may not be

20. possible to ensure adequate protection in all cases against high velocity missiles, such as high velocity rifle bullets.

An object of the invention is to provide a protective

25. shield suitable for use as a protection against high velocity missiles.

According to the invention therefore there is provided

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- a protective shield to be used in front of a person's body to protect such person against injury by a bullet or other missile, said shield comprising a supported layer of a rigid, brittle material having a
5. high degree of hardness, and a penetration resisting and impact-absorbing backing structure on that side of the said supported layer which in use faces the person's body.
  10. With this arrangement, when a high velocity missile strikes the said supported layer, energy can be absorbed as the brittle material shatters and the missile can be broken into fragments due to the hardness of the material. The resulting low velocity missile fragments can then
  15. be easily stopped by the backing structure.

- Any suitable kind of brittle material may be used although a glass or ceramic material is preferred, particularly a silicon carbide or alumina, or boron carbide
20. ceramic. One suitable material is a self-bonded silicon carbide manufactured and sold under the name Refel by British Nuclear Fuels Limited. This material has a hardness in the range 2500-3500 Kg/mm<sup>2</sup> and a rupture modulus of about 525 MN/m<sup>2</sup> (76000 p.s.i.). Also suitable
  25. are Sintox alumina ceramics manufactured and sold by Smiths Industries Limited.

- The brittle material may be used in any suitable form but preferably a sheet structure is employed which is
30. made up from individual small plates placed edge-to-edge. Most preferably, hexagonal plates are used. In order to encourage cracking of the material in a predetermined manner on impact, small holes or other points or lines of weakness may be provided therein. In this way it is
  35. possible to facilitate cracking into pieces which are

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neither too small nor too large to effect good fragmentation of the missile.

The brittle material may be supported by bonding same

5. to a sheet which may be stiff or semi-stiff. Such sheet may comprise one or more layers of a closely woven fabric which is made from aramid fibres of high tensile strength and high stretch resistance such as to be capable of resisting penetration by a bullet, particularly the
10. aramid material sold by Du Pont under the trade name Kevlar.

The said supported layer may be provided with a front protective layer to protect against inadvertent

15. breakage of the brittle material, for example if the shield is dropped. This protective layer may comprise one or more polycarbonate sheets and/or a foam plastics sheet and/or a polycarbonate or other facing applied direct to the brittle material. Also, the supported
20. layer may be wrapped in a sheet of strong material such as the above-mentioned aramid fabric, in order to prevent undue collapse and disintegration of the supported layer after it has been hit by a missile. The supported layer may be contained within a plastics or fabric bag.
- 25.

The said backing structure may be in the form of a sheet made from one or more layers of the above-mentioned aramid fabric and this sheet may be backed with one or more polycarbonate sheets and/or one or more sheets of

30. impact-absorbing plastics material. In a particularly preferred embodiment, the said backing structure comprises a shield as described in the aforementioned prior Patent Specification.

35. The said backing structure and the said supported layer

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may be formed separately whereby they can be used together or individually as required.

Most conveniently, an article of clothing in the form

5. of a vest or jacket or apron is provided and this has two pouches or pockets to receive respectively the backing structure and the supported layer.

The invention will now be described further by way of

10. example only and with reference to the accompanying drawings in which:-

Figs. 1 and 2 are front and back portions of an article of clothing for use with one form of a

15. shield according to the invention; and

Fig. 3 is an exaggerated sectional representation of the shield.

The article of clothing has front and back shaped

20. portions 1, 2 formed from stitched fabric (such as nylon) which can be held together by engagement of Velcro (Registered Trade Mark) pads to define a vest-shaped garment.

25. The front portion 1 has shoulder parts 3 provided respectively with two Velcro pads 4, and also two side flaps 5 provided respectively with two tabs 6 thereon. Such tabs 6 overlie the flaps 5 and are fixed to the front portion 1 at the two ends 7 of the tabs which
30. face each other. The tabs 6 have Velcro pads 8 on the undersides of the free ends thereof.

The front portion 1 also has an open-topped pouch 9 overlying the breast region and stitched in position

35. at its bottom edge. Velcro pads 10 are provided at the top of the pouch. A pocket 11 (as shown in dotted

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- lines in Fig. 1) is provided on the inside of the front portion, such pocket being defined by overlapping inner sheets 12, 13 of fabric which are stitched to the front portion 1 around the edges thereof and which define a
5. pocket opening between the central overlapping free edges thereof.

- The back portion 2 has shoulder strips 14 with overlying tabs 15 fixed in position at their lower ends
10. only. Velcro pads 16, 17 are provided on the undersides of the strips 14 and the tabs 15. There are also side flaps 18 with Velcro pads 19 thereon.

- In use, the front and back portions 1, 2 are positioned
15. in front of and behind a person with the side flaps 18 of the back portion 2 overlying the side flaps 5 of the front portion 1, the shoulder strips 14 overlying the shoulder parts 3, the tabs 15 overlying the pouch 9, and the tabs 6 overlying the flaps 18. The super-
20. imposed Velcro pads 4 and 16, 10 and 17, 8 and 19, are engaged with each other to hold the portions 1, 2 together.

- Before fitting the front and back portions 1, 2 a
25. protective shield is incorporated therein, such shield, as shown in Fig. 3, having front and back parts which are inserted respectively within the pouch 9 and the pocket 11.

30. The front part comprises a peripherally sealed nylon bag 20 containing rectangular layers from front to back:

- A) One or more thin flexible sheets of the transparent polycarbonate sold under the trade name
35. LEXAN. the or each such sheet being of 0.75 mm thickness.

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- B) A layer of hexagonal ceramic plates (say about 7mm thick and about 75mm across) formed for example from Refel (as hereinbefore described). The plates are placed edge-to-edge and are bonded to the next described layer C. The first
5. described layer A may also be bonded to the plates. As a bonding agent a thick silicone rubber, such as Berger Silicone 381 may be used.
- C) One or more sheets (say 10 sheets) of a coarse
10. Kevlar fabric. The sheets may be bonded together (with the above described bonding agent) to give a stiff laminate.

- Within the bag 20, a sheet of Kevlar 21 is wrapped
15. around the layers A, B, C.

- The rear part of the shield comprises a peripherally sealed nylon bag 22 (shaped to conform to the pocket) containing layers (some or all of which are shaped
20. similarly to the bag) from front to back.

- D) A number of sheets of fabric woven from Kevlar (say Kevlar 29 to 49 woven with 31-31 (warp and weft) picks per inch (2.54 cm) from 1000 or 1500 denier yarn) such sheets being stitched together
25. in a bundle and/or bonded together in pairs. Fifteen to 30 sheets in all may be used.
- E) One or more sheets of LEXAN as described above.
- F) One or more resiliently compressible sheets of a foamed plastics material particularly a closed
30. cell cross-linked polyethylene foam such as that sold under the trade name PLASTAZOTE or EVAZOTE, the total thickness of the plastics sheet or sheets being 0.5mm to 12mm.

35. With this arrangement, when a high velocity bullet

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- strikes the protective shield, the bullet hits the ceramic plates B causing these to shatter and the bullet to fragment. Small pieces of the bullet, now moving at a much reduced velocity may penetrate the front part
5. of the shield but are stopped by the back part. The Kevlar sheets D in the back of the shield act to prevent or limit penetration whilst the polycarbonate and foamed plastics sheets E, F absorb impact shock and limit transmission thereof to the person's body. The
10. layer A protects the plates B against breakage, for example if the shield is accidentally dropped or roughly handled. The sheet 21 holds the plates B together after impact so that some protection can be afforded against a subsequent impact.
- 15.
- It is of course to be understood that the invention is not intended to be restricted to the details of the above embodiment and thus, for example, it will be appreciated that parameters such as the thickness of
20. the various layers, the number of individual sheets in the layers, and so on will be selected in accordance with requirements.

- Further, the shield is not limited to the shape and
25. mode of utilisation thereof as shown in the drawings but may be suitably shaped and adapted for location relative to a person's body as required. For example, the front portion may have a lower depending pouch into which a separate groin protecting shield, formed in like manner
30. to the back part of the shield 1, can be inserted.

- Since the front part of the shield is separate from the back part, the front part may be removed leaving only the back part in the case where protection against
35. high velocity impact is not required.



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Instead of separate ceramic plates it is possible to use a single large plate which if desired may be curved or otherwise shaped.

5. Additionally or alternatively to the use of ceramic plates as the brittle material it is possible to use a one-piece sheet or a sheet formed from edge-to-edge plates made of a metal such as steel or other material which has the properties of a rigid, brittle material
10. as considered in relation to the impact of a bullet therewith.

- The tabs 15 used to secure the upper part of the front pouch 9 to the front part 1 of the vest may be of
15. sufficient length and/or may be formed from an elastic material such as to permit a degree of movement of the pouch 9 relative to the vest part 1 behind same. In this way movement of the wearer and in particular normal breathing movements of the wearer's chest need
  20. not be unduly restricted despite the weight and rigidity of the layers within the pouch 9.

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## Claims:

1. A protective shield to be used in front of a person's body to protect such person against injury by a bullet or other missile and comprising a penetration resisting and impact-absorbing structure characterised in that  
said shield further comprises a supported layer of a rigid, brittle material (B) having a high degree of hardness, said structure being arranged on that  
10. side of the said supported layer which in use faces the person's body.
2. A shield according to claim 1, characterised in that  
15. the brittle material (B) comprises a glass or ceramic material such a silicon carbide or alumina or boron carbide ceramic.
3. A shield according to claim 1 or 2,  
20. characterised in that  
the brittle material (B) is in the form of a sheet made up of individual small plates placed edge-to-edge.
4. A shield according to any one of claims 1 to 3,  
25. characterised in that  
small holes or other points or lines of weakness are provided in the brittle material (B).
5. A shield according to any one of claims 1 to 4,  
30. characterised in that  
the brittle material (B) is supported by bonding same to a stiff or semi-stiff sheet (C).
6. A shield according to claim 5,  
35. characterised in that

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said stiff or semi-stiff sheet (C) comprises one or more layers of a closely woven fabric made from aramid fibre of high tensile strength and high stretch resistance.

5.

7. A shield according to any one of claims 1 to 6, characterised in that said supported layer is provided with a front protective layer (A) in the form of one or more plastics sheets.

10.

8. A shield according to any one of claims 1 to 7, characterised in that the said supported layer is wrapped in a sheet of strong material (21).

15.

9. A shield according to any one of claims 1 to 8, characterised in that the said supported layer is contained within a bag (20).

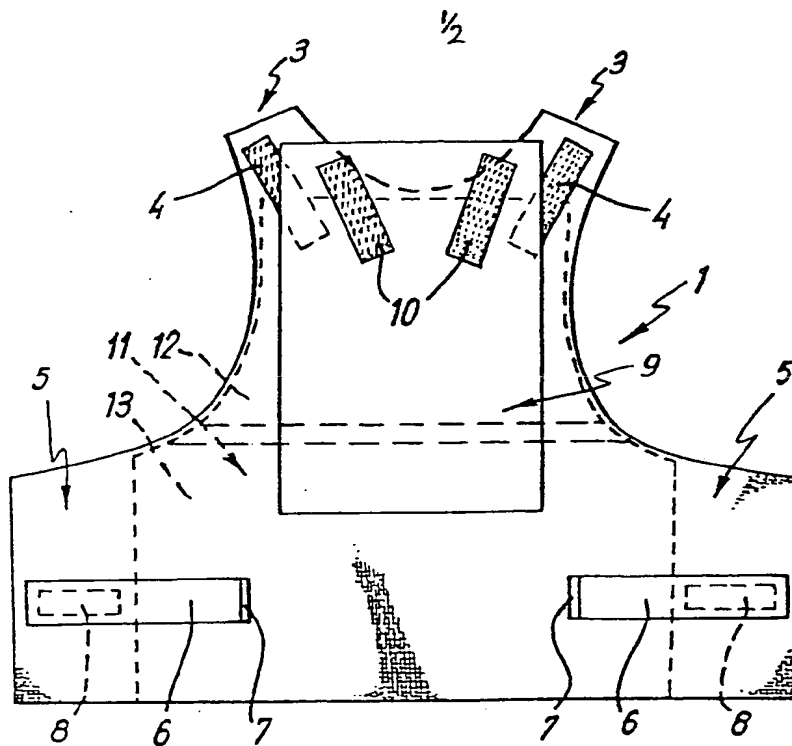
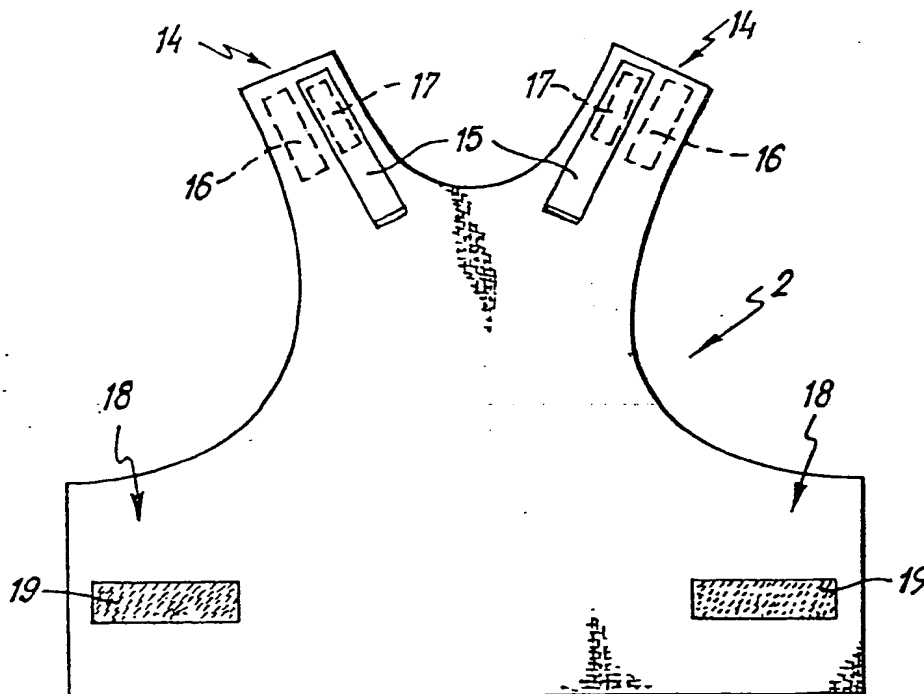
20. 10. A shield according to any one of claims 1 to 9, characterised in that the said backing structure comprises: a sheet (D) made from one or more layers of a closely woven fabric which is made from aramid fibres of high tensile strength and high stretch resistance such as to be capable of resisting penetration by a bullet, and behind said fabric sheet (D) one or more sheets (E) formed from an impact-absorbing polycarbonate plastics material.

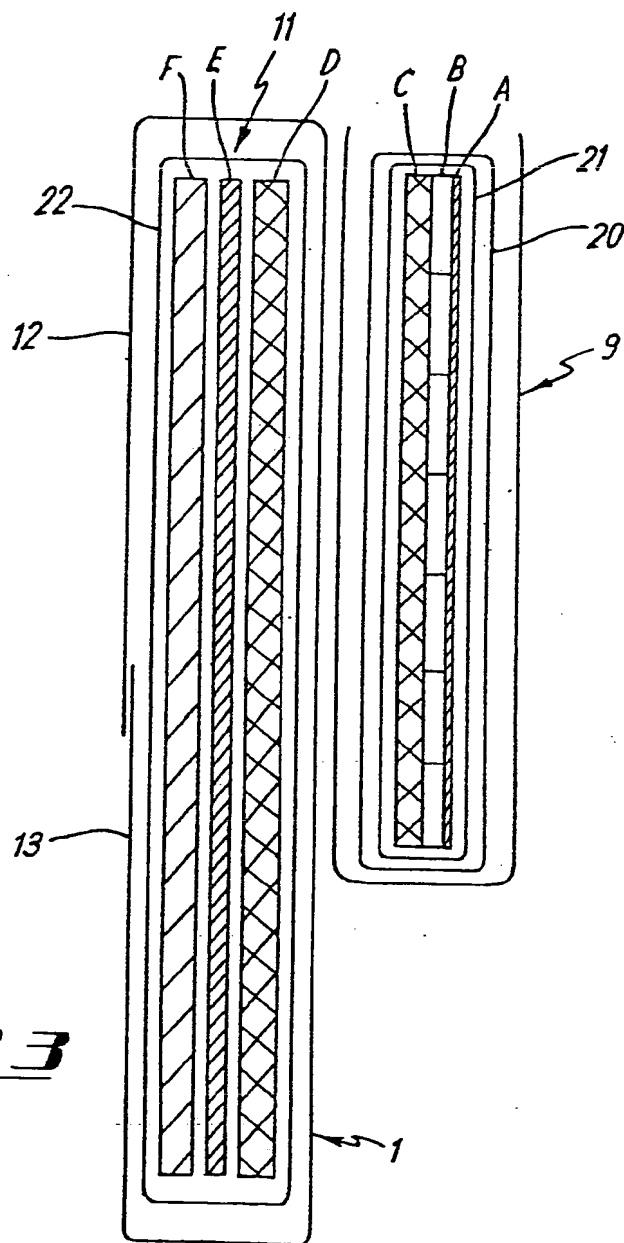
30. 11. A shield according to any one of claims 1 to 10, characterised in that the said backing structure and the said supported layer are formed separately whereby the supported layer can be removed to permit use of the backing structure alone.

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12. A shield according to any one of claims 1 to 11, which is an article of clothing in the form of a vest or jacket or apron characterised in that
5. two pouches (9, 11) or pockets are provided in the article of clothing to receive respectively the backing structure and the supported layer.

**FIG. 1****FIG. 2**

$\frac{2}{2}$ **FIG. 3**